

Claims

- [c1] 1. A method for connecting signals between a radio integrated circuit (IC) and a signal processing device comprising the step of multiplexing two or more signals on a connection pin between the radio IC and the signal processing device.
- [c2] 2. The method of claim 1, wherein the step of multiplexing comprises multiplexing transmit and receive signals on the connection pin such that during a transmit mode a transmit signal is coupled on the connection pin from the signal processing device to the radio IC, and during a receive mode a receive signal is coupled from the radio IC on the connection pin to the signal processing device.
- [c3] 3. The method of claim 2, wherein the step of multiplexing is performed on each of a plurality of connection pins between the radio IC and the signal processing device for a plurality of corresponding transmit and receive signals.
- [c4] 4. The method of claim 2, wherein the step of multiplexing is performed on a connection pin for transmit and receive in-phase (I) signals and on another connection

pin for transmit and receive quadrature (Q) signals.

- [c5] 5. The method of claim 2, wherein the step of multiplexing is performed on each of a pair of connection pins associated with differential transmit signals and differential receive signals.
- [c6] 6. The method of claim 1, wherein in a transmit mode, the step of multiplexing comprises multiplexing a transmit in-phase (I) signal and a transmit quadrature (Q) signal on a connection pin between the radio IC and the signal processing device.
- [c7] 7. The method of claim 1, wherein in a receive mode, the step of multiplexing comprises multiplexing a receive in-phase (I) signal and a receive quadrature (Q) signal on a connection pin between the radio IC and the signal processing device.
- [c8] 8. A radio transceiver integrated circuit (IC) comprising:
 - a. at least one receiver that produces a receive signal and at least one transmitter that processes a transmit signal for transmission; and
 - b. a connection pin that couples the transmit signal supplied to the radio IC for processing by the transmitter during a transmit mode and couples as output the receive signal produced by the receiver during a receive

mode.

- [c9] 9. The radio IC of claim 8, and further comprising a switch coupled to the connection pin that in a first position during the transmit mode couples the connection pin to the transmitter to connect the transmit signal to the radio IC, and in a second position during the receive mode couples the connection pin to output the receive signal produced by the receiver.
- [c10] 10. The radio IC of claim 8, and further comprising a plurality of transmitters and a plurality of receivers such that pair of a transmitter and a receiver are associated with a corresponding one of a plurality of antennas connected to the radio IC, and further comprising a plurality of connection pins each associated with a corresponding transmitter/receiver pair that couples a corresponding transmit signal to the radio IC during the transmit mode for transmission processing and couples a corresponding receive signal produced by a corresponding receiver during the receive mode.
- [c11] 11. The radio IC of claim 10, and further comprising a plurality of switches associated with a corresponding connection pin, each switch in a first position couples the corresponding connection pin to the transmitter during the transmit mode to connect a corresponding trans-

mit signal to the radio IC, and in a second position during the receive mode couples the connection pin to a corresponding receive signal produced by the corresponding receiver.

- [c12] 12. A system comprising the radio IC of claim 10, and further comprising a signal processing device coupled to the radio transceiver via the plurality of connection pins, wherein the signal processing device produces the plurality of transmit signals and processes the plurality of receive signals.
- [c13] 13. The radio IC of claim 8, wherein the at least one transmitter and at least one receiver each have an in-phase (I) signal path and a quadrature (Q) signal path, and further comprising a connection pin associated with the in-phase (I) signal path that is shared for a transmit I signal or a receive I signal, and a connection pin associated with the quadrature (Q) signal path that is shared for a transmit Q signal or a receive Q signal.
- [c14] 14. A system comprising the radio IC of claim 8, and further comprising an analog-to-digital converter (ADC) that is coupled to the connection pin that in the receive mode converts the receive signal to a digital signal and a digital-to-analog converter (DAC) that in the transmit mode converts the transmit signal to an analog signal

that is coupled to the connection pin, and a control circuit that controls the ADC and the DAC such that in the receive mode, the DAC is switched to a power down mode which has a high impedance at the DAC output to minimize signal coupling from the output of the DAC onto the connection pin, and during the transmit mode, a sample clock of the ADC is held in a hold state to create a high input impedance at the ADC input to minimize signal coupling from the DAC into the input of the ADC.

- [c15] 15. The system of claim 14, and further comprising a signal processing device coupled to the radio IC via the connection pin, and wherein the ADC, DAC and control circuit are part of the signal processing device and the signal processing device produces the transmit signal and processes the receive signal output by the radio IC.
- [c16] 16. A system comprising the radio IC of claim 8, and further comprising a signal processing device coupled to the radio IC via the connection pin, wherein the signal processing device produces the transmit signal and processes the receive signal output by the radio IC.
- [c17] 17. The radio IC of claim 8, wherein the transmitter and receiver each have differential signal paths, and further comprising a pair of connection pins that are shared to couple differential transmit signals supplied to the radio

IC for processing by the transmitter during the transmit mode and to couple as output differential receive signals produced by the receiver during the receive mode.

- [c18] 18. A radio transceiver integrated circuit (IC) comprising:
- a. at least one transmitter and at least one receiver, each of which includes an in-phase (I) signal path and a quadrature (Q) signal path;
 - b. a transmitter connection pin on which a transmit I signal and a transmit Q signal are multiplexed for connection to the respective I and Q signal paths of the transmitter; and
 - c. a receiver connection pin on which a receive I signal and a receive Q signal are multiplexed from the respective I and Q signal paths of the receiver.
- [c19] 19. The radio IC of claim 18, and further comprising a first multiplexer circuit that couples from the transmitter connection pin the transmit I and transmit Q signals during different time intervals for connection to the I and Q signal paths, respectively, of the transmitter.
- [c20] 20. The radio IC of claim 19, wherein the first multiplexer circuit alternately couples the transmit I and transmit Q signals, respectively, from the transmitter pin to the I and Q signal paths, respectively, of the transmitter.

- [c21] 21. The radio IC of claim 19, and further comprising a second multiplexer circuit that couples during different time intervals the receive I and receive Q signals to the receiver connection pin from the I and Q signal paths, respectively, of the receiver.
- [c22] 22. The radio IC of claim 21, wherein the second multiplexer circuit alternately couples the receive I and receive Q signals to the receiver connection pin from the I and Q paths, respectively, of the receiver.
- [c23] 23. The radio IC of claim 18, and further comprising a multiplexer circuit that during a receive mode couples to the receiver connection pin the receive I and receive Q signals during different time intervals from the I and Q signal paths, respectively, of the receiver, and during a transmit mode, couples from the transmitter connection pin the transmit I and transmit Q signals during different time intervals to the I and Q signal paths, respectively of the transmitter.
- [c24] 24. The radio IC of claim 23, and further comprising a timing circuit that supplies a timing signal to the multiplexer circuit to control the timing of the first and second multiplexer circuits.
- [c25] 25. The radio IC of claim 18, and further comprising a

plurality of transmitters and a plurality of receivers such that a pair of a transmitter and a receiver are associated with a corresponding one of a plurality of antennas connected to the radio IC, and further comprising a plurality of transmitter connection pins each associated with a corresponding transmitter and a plurality of receiver connection pins each associated with a corresponding receiver, each transmitter connection pin on which corresponding transmit I and transmit Q signals are multiplexed for connection to the I and Q signal paths, respectively, of the associated transmitter and each receiver connection pin on which corresponding receive I and receive Q signals are multiplexed for connection from the I and Q signal paths, respectively, of the associated receiver.

[c26] 26. The radio IC of claim 25, and further comprising a plurality of transmitter multiplexer circuits each associated with a corresponding transmitter to multiplex the corresponding transmit I signal and transmit Q signal from the corresponding transmitter connection pin to the respective I and Q signal paths of the corresponding transmitter.

[c27] 27. The radio IC of claim 26, wherein each transmitter multiplexer circuit alternately couples the corresponding transmit I signal and transmit Q signal from the corre-

sponding transmitter connection pin to the respective I and Q signal paths of the corresponding transmitter.

[c28] 28. The radio IC of claim 25, and further comprising a plurality of receiver multiplexer circuits each associated with a corresponding receiver to multiplex the corresponding receive I signal and receive Q signal from the respective signal paths of the corresponding receiver to the corresponding receiver connection pin.

[c29] 29. The radio IC of claim 28, wherein each receiver multiplexer circuit alternately couples the corresponding receive I and receive Q signal to the corresponding receiver connection pin from the respective I and Q signal paths of the corresponding receiver.

[c30] 30. The radio IC of claim 25, and further comprising a plurality of multiplexer circuits each associated with a corresponding transmitter/receiver pair that multiplexes the corresponding transmit I signal and transmit Q signal from the corresponding transmitter connection pin to the respective I and Q signal paths of the corresponding transmitter, and that multiplexes the corresponding receive I signal and receive Q signal from the respective I and Q signal paths of the corresponding receiver to the corresponding receiver connection pin.

- [c31] 31. The radio IC of claim 25, wherein each of the I and Q signal paths of each the of transmitters and receivers having differential signal paths, and further comprising a plurality of pairs of transmitter connection pins on which corresponding differential transmit I and transmit Q signals are multiplexed, and a plurality of pairs of receiver connection pins on which corresponding differential receive I and receive Q signals are multiplexed.
- [c32] 32. The radio IC of claim 18, wherein each of the I and Q signal paths of the transmitter and receiver are differential, and further comprising a pair of transmitter connection pins on which differential transmit I and transmit Q signals are multiplexed, and a pair of receiver connection pins on which differential receive I and receive Q signals are multiplexed.
- [c33] 33. The radio IC of claim 32, and further comprising a plurality of transmitters and a plurality of receivers such that a pair of a transmitter and a receiver are associated with a corresponding one of a plurality of antennas connected to the radio IC, and further comprising a plurality of pairs of transmitter connection pins each pair associated with a corresponding transmitter and a plurality of pairs of receiver connection pins each pair associated with a corresponding receiver, each pair of transmitter connection pins on which corresponding differential

transmit I and transmit Q signals are multiplexed to the I and Q signal paths, respectively, of the associated transmitter and each pair of receiver connection pin on which corresponding differential receive I and receive Q signals are multiplexed from the I and Q signal paths, respectively, of the associated receiver.

[c34] 34. A system comprising the radio IC of claim 18, and further comprising a signal processing device coupled to the radio IC that supplies the transmit I signal and transmit Q signal to the radio IC for transmission processing and processes the receive I signal and receive Q signal from the radio IC.

[c35] 35. The system of claim 34, and further comprising a timing circuit in the radio IC and a timing circuit in the signal processing device, wherein the timing circuit in the radio transceiver or timing circuit in the signal processing device generates timing signals that are coupled to the other timing circuit in order to coordinate the transfer of transmit I and transmit Q signals from the signal processing device to the radio IC and to coordinate transfer of the receive I and receive Q signals from the radio IC to the signal processing device.

[c36] 36. The system of claim 35, wherein the radio IC further comprises at least one multiplexer circuit coupled to the

timing circuit in the radio IC and is responsive to timing signals supplied by the timing circuit to couple from the transmitter connection pin the transmit I and transmit Q signals during different time intervals for connection to the I and Q signal paths, respectively, of the transmitter, and to couple to the receiver connection pin the receive I and receive Q signals during different time intervals from the I and Q signal paths, respectively, of the receiver.

- [c37] 37. A method for connecting signals between at least one of a radio transmitter and a radio receiver and a signal processing device, the method comprising the step of multiplexing two or more signals on a connection pin between the signal processing device and one or both of the radio transmitter and radio receiver.
- [c38] 38. The method of claim 37, wherein the step of multiplexing comprises multiplexing transmit and receive signals on the connection pin such that during a transmit mode a transmit signal is coupled on the connection pin from the signal processing device to the radio transmitter, and during a receive mode a receive signal is coupled from the radio receiver on the connection pin to the signal processing device.